Breaking the AZ Barrier in Geocenter Estimation

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Initial GPS results for the estimated location of the Earth's center of mass (the geocenter) using 21 Rogue receiver sites from the GIG'91 global GPS campaign showed 10-15 cm agreement with satellite laser ranging (SLR). These solutions were affected to some extent by a significant deficit of coverage in the southern hemisphere and holes in the GPS constellation. The IGS'92 Campaign provided data from 30 globally distributed network with Rogue receiver sites tracking 18 GPS satellites. The IGS '92 geocenter estimate averaged over several months of GPS data was offset from ITRF'91 by AX = 0.0 ± 1.4 cm, AY = 1.5 ± 1.3 cm, and AZ = – 8.2 ± 3.() cm. The larger discrepancy in Z was attributed in part, as with GIG'91, to the lesser number of participating sites in southern hemisphere. In addition, the daily scatter in Z estimates was relatively large, on the order of 10 cm rms.

New GPS-based solutions for the geocenter have been determined using data from 1993 with only 13 sites of a global network combined with GPS flight data from the receiver on board the Topex/Poseidon satellite. Daily solutions for 12 days (March 5–16, 1993) were determined, The adopted estimation model corresponds to the standard strategy adopted by the Topex GPS precise orbit determination team at JPL. Daily estimates of the geocenter along with GPS orbits, Earth orientation parameters, Topex/Poseidon orbits and station locations were obtained. These results were then compared against the results obtained by excluding Topex flight receiver data for the same 12-day period. There is a dramatic improvement in the AZ offset when the data from Topex/Poseidon are included: AZ = -0.11 ± 2.76 cm as compared to AZ = -4.34 ± 11.21 cm without Topex/Poseidon data. With the GPS Topex/Poseidon flight data included, all three geocenter components are accurate to the cm-level based on daily solutions — apparently as accurate as any other known solutions for the geocenter. The uneven distribution of sites in northern and southern hemisphere has always caused relatively weaker GPS estimates of AZ for geocenter location. Other space geodetic techniques (SLR, lunar laser ranging) are also generally weaker in their Z component solutions for the geocenter. This may also be due in part to the E-W rotation of the Earth, which provides a naturally greater variation in geometrical information in X and Y as compared to Z, The highly inclined, low altitude, and shorter period orbit of Topex/Poseidon seem to provide this missing coverage quite effectively through GPS tracking.

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